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## **Biomimetic aquaporin forward osmosis membrane for removal of frequently found pesticides from danish groundwater network**

Nikbakht Fini, Mahdi; Madsen, Henrik Tækker; Muff, Jens

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# ***BIOMIMETIC AQUAPORIN FORWARD OSMOSIS MEMBRANE FOR REMOVAL OF FREQUENTLY FOUND PESTICIDES FROM DANISH GROUNDWATER NETWORK***

*MAHDI NIKBAKHT FINI, HENRIK TÆKKER MADSEN, JENS MUFF*



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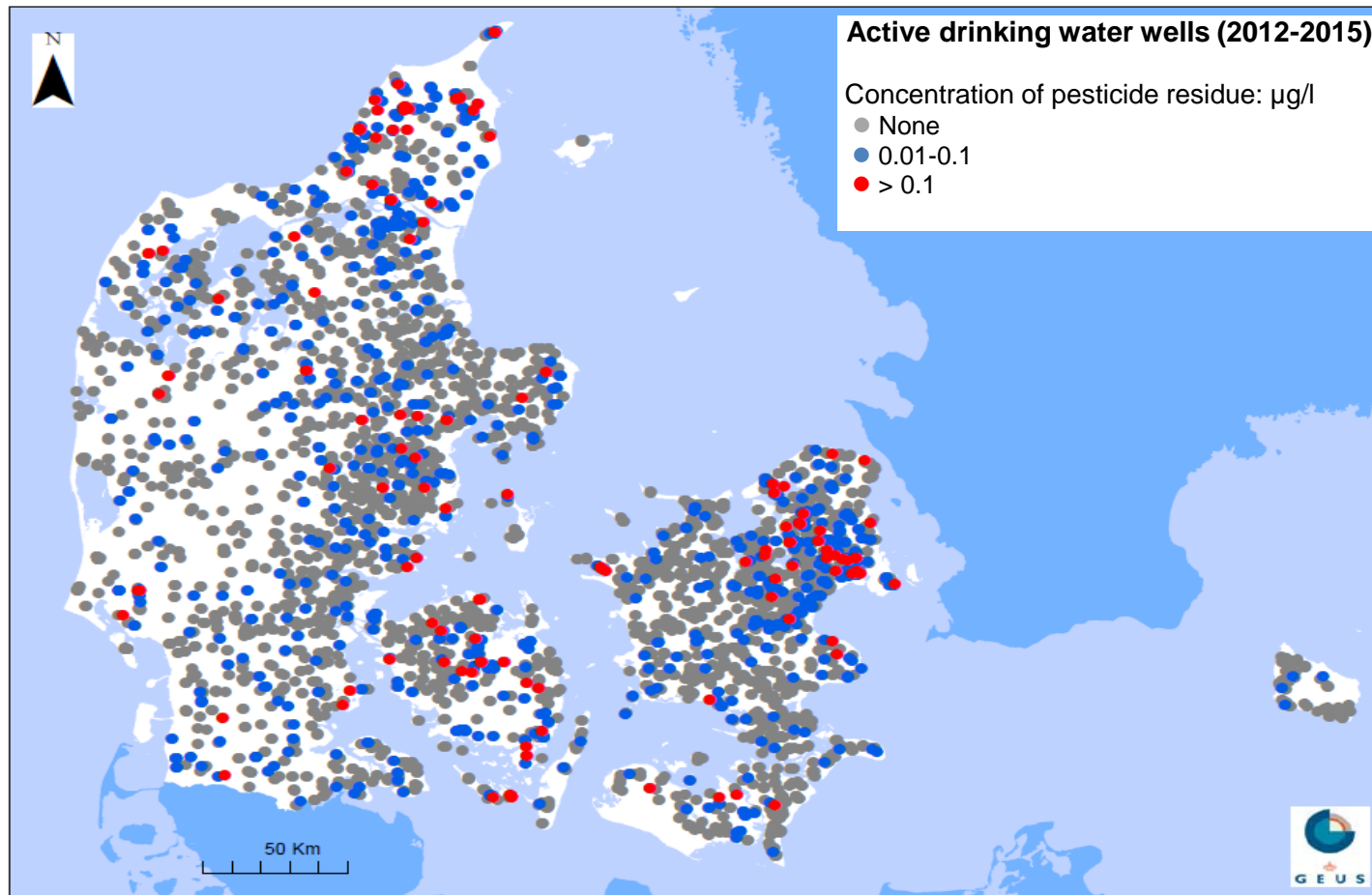
DEPARTMENT OF CHEMISTRY AND BIOSCIENCE  
SECTION OF CHEMICAL ENGINEERING



**NoFS**

# Introduction

Map of pesticide contamination



- Found in 27% of active DW wells
- > 0.1 µg/L in 3.6%
- 130 wells were closed within 1993-2009



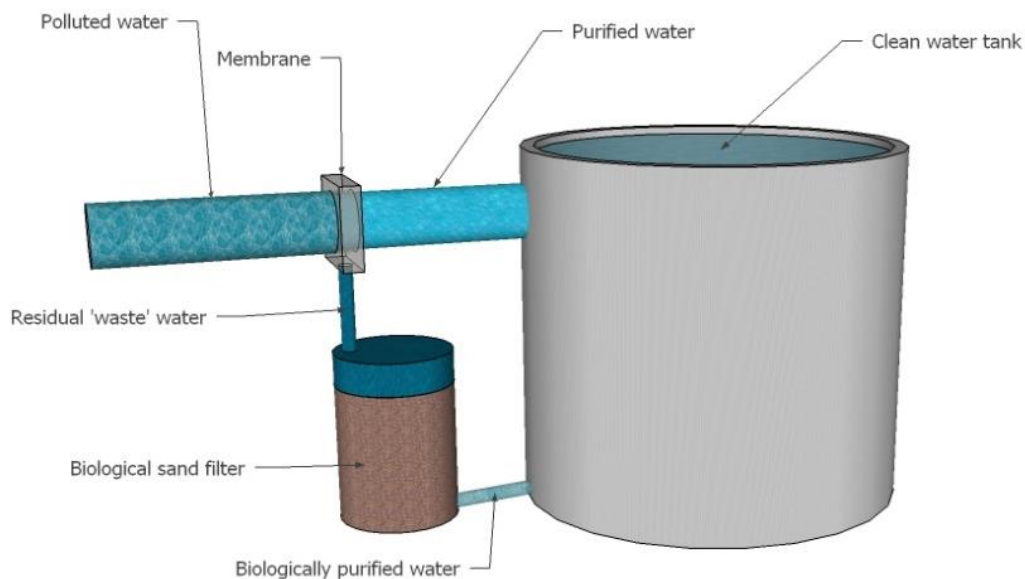
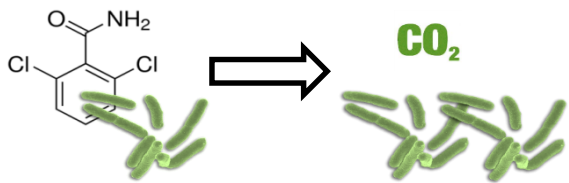
**Membrane separation:**

~ 90% ultra pure water

~ 10% residual 'waste' water with high concentration of pollutants, carbon, minerals etc.

**Biofilter:**

Added specific pesticide degrader organisms to sand filters



*Ellegaard-Jensen et al. 2017*

**Mineralization**

Treated concentrate is mixed with permeate

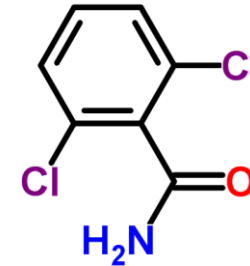


# Studied pesticides

1. BAM (2-6 Dichlorobenzamide)

MW: 190.028 g/mol

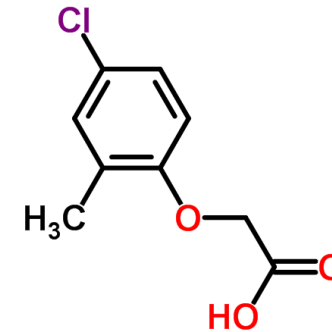
transformation product of Dichlobenil



In 2015, Found in **16%** of sampled wells of which **9.4%** was above 0.1 µg/L.

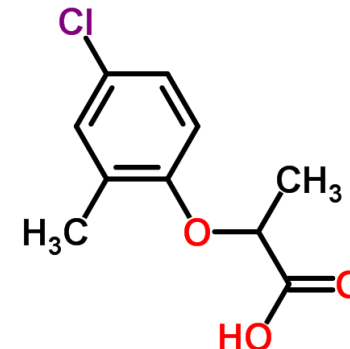
2. MCPA (2-methyl-4-chlorophenoxyacetic acid)

MW: 200.62 g/mol



3. MCPP (methylchlorophenoxypropionic acid)

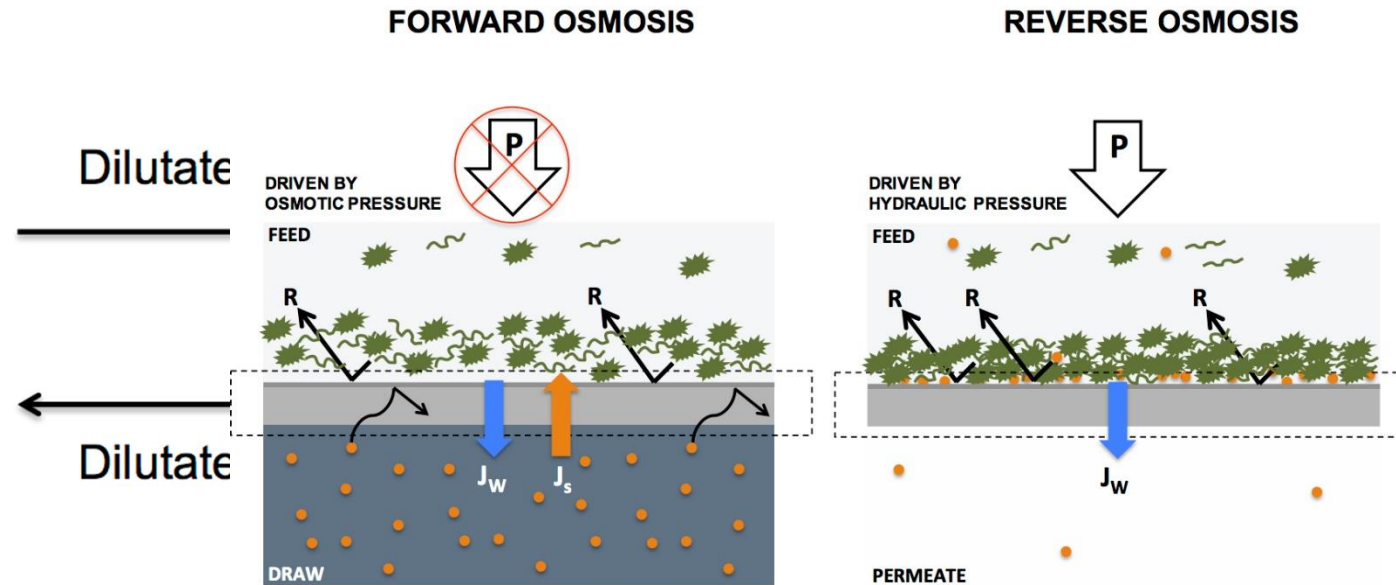
MW: 214.65 g/mol



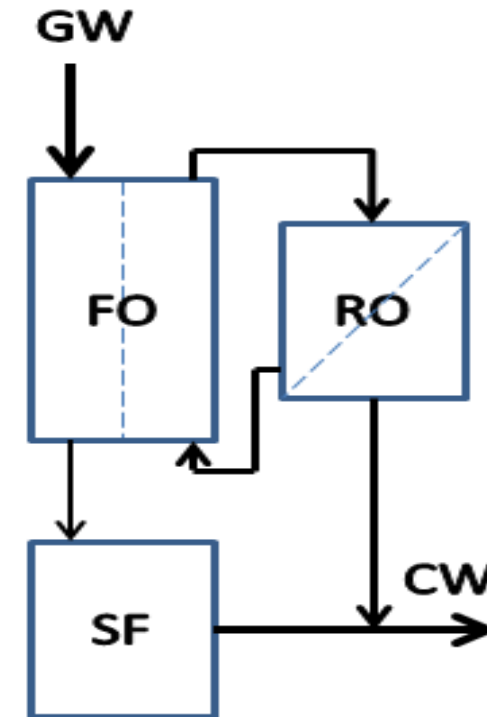
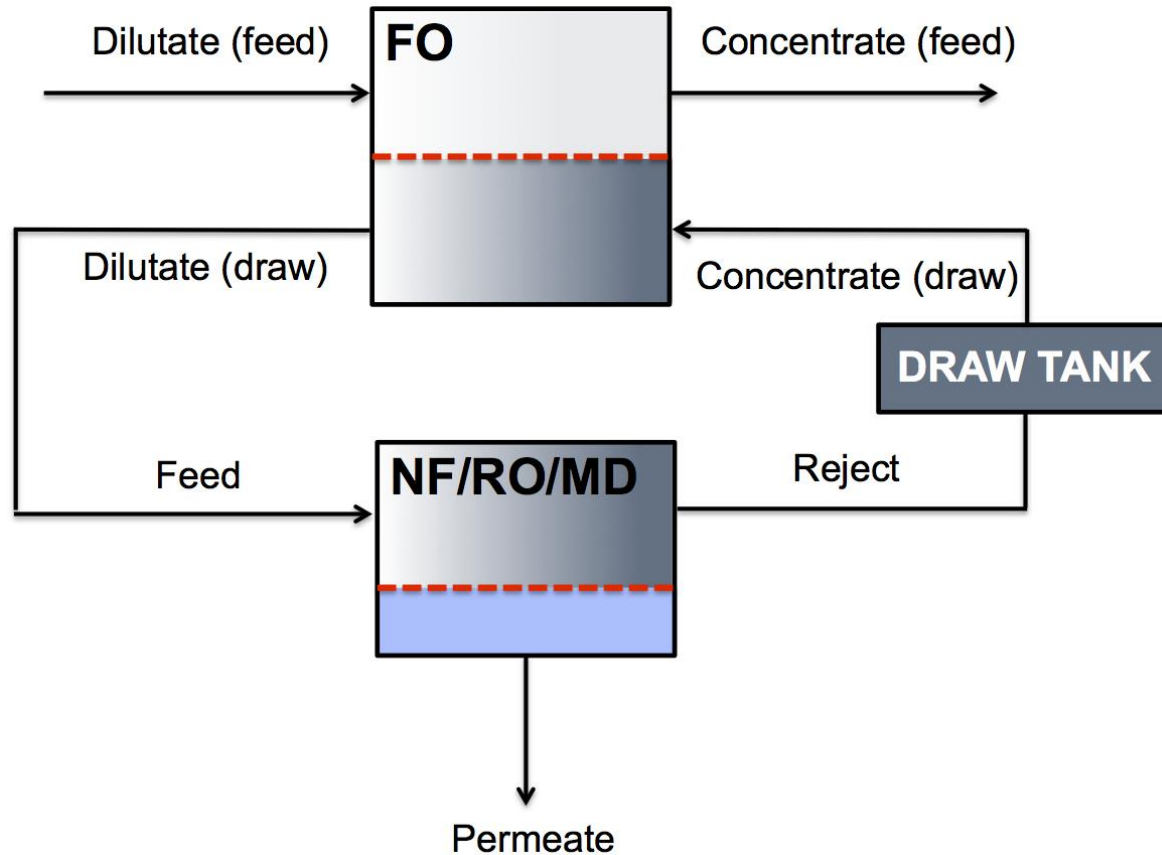
# Forward Osmosis

Advantages of FO process

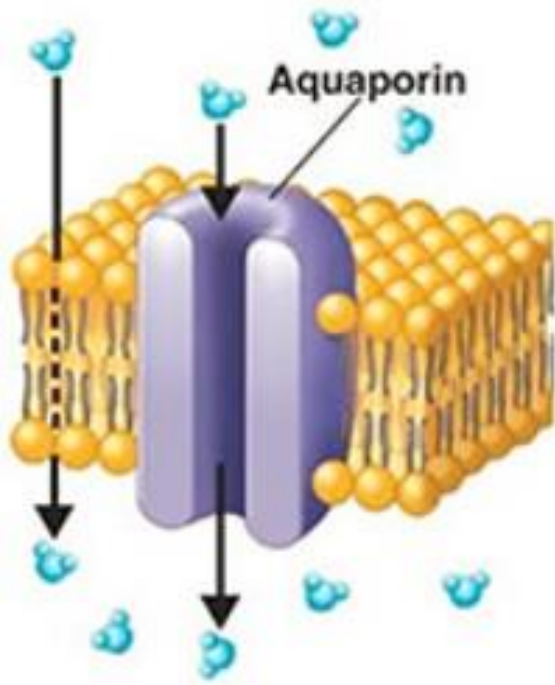
- Less energy requirement
- Less risk of fouling/scaling



# Use of FO in MEM2BIO project



# Aquaporin FO membrane



- Incorporated aquaporin proteins in the membrane
- Higher permeability compared to traditional FO membranes



34 cm<sup>2</sup>



2.3 m<sup>2</sup>



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# FO setups



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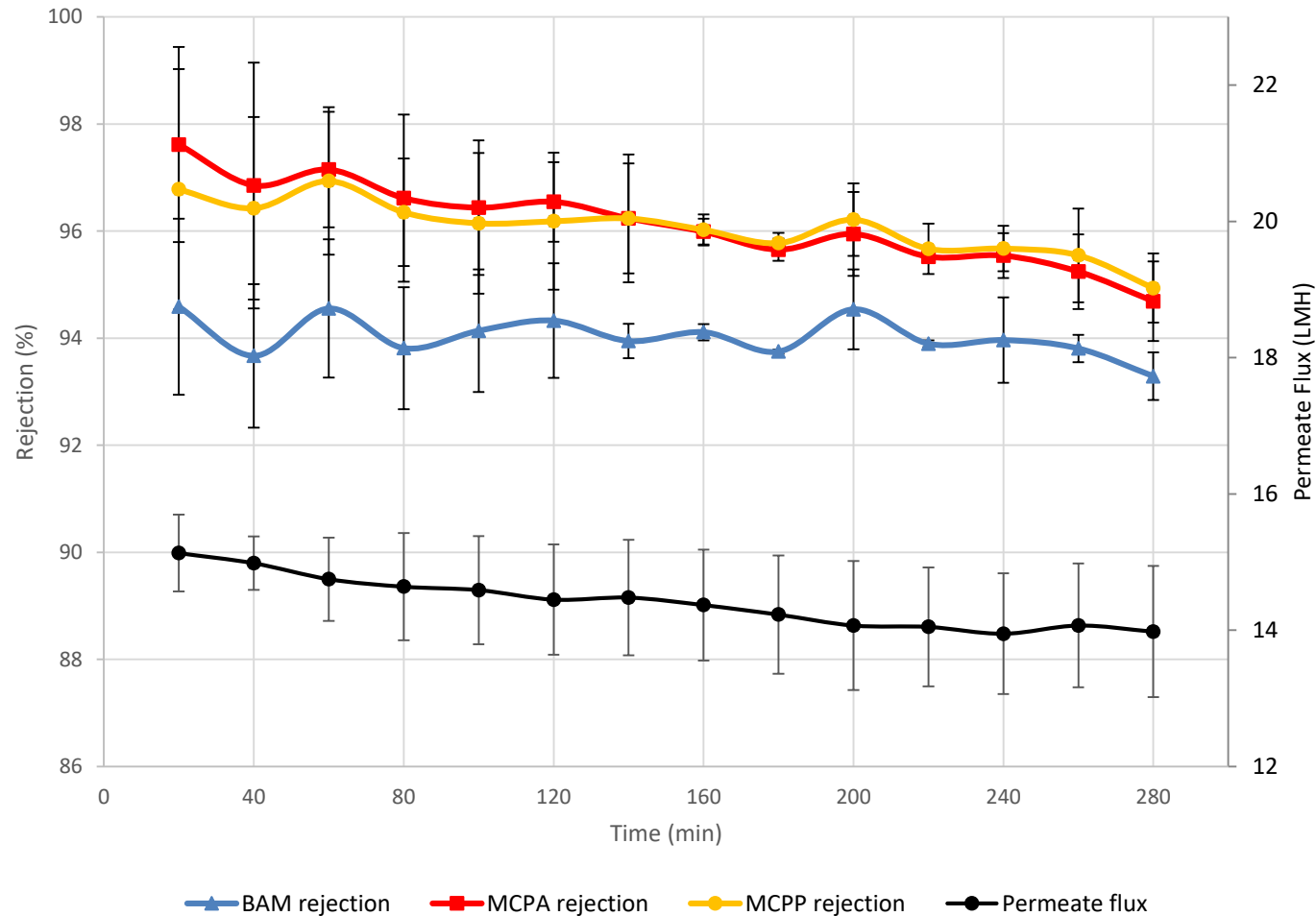
# Membrane characterization

Parameter	Value
NaCl rejection in RO (%)	$99.4 \pm 0.2$
Pure water permeate flux (LMH)	$15.2 \pm 0.6$
Reverse salt flux ( $\text{g m}^{-2} \text{h}^{-1}$ )	$5.6 \pm 0.5$ ( $1.7 \pm 0.4$ by HF)
Water permeability, A ( $\text{L m}^{-2} \text{h}^{-1} \text{bar}$ )	$3.0 \pm 0.2$
Salt permeability, B ( $\text{L m}^{-2} \text{h}^{-1}$ )	$0.1 \pm 0.03$
Membrane structural parameter, S ( $\mu\text{m}$ )	$305 \pm 43$
Contact angle ( $^\circ$ )	$28.6 \pm 3.4$
Zeta potential at pH=5.3 (mV)	$-21 \pm 2$



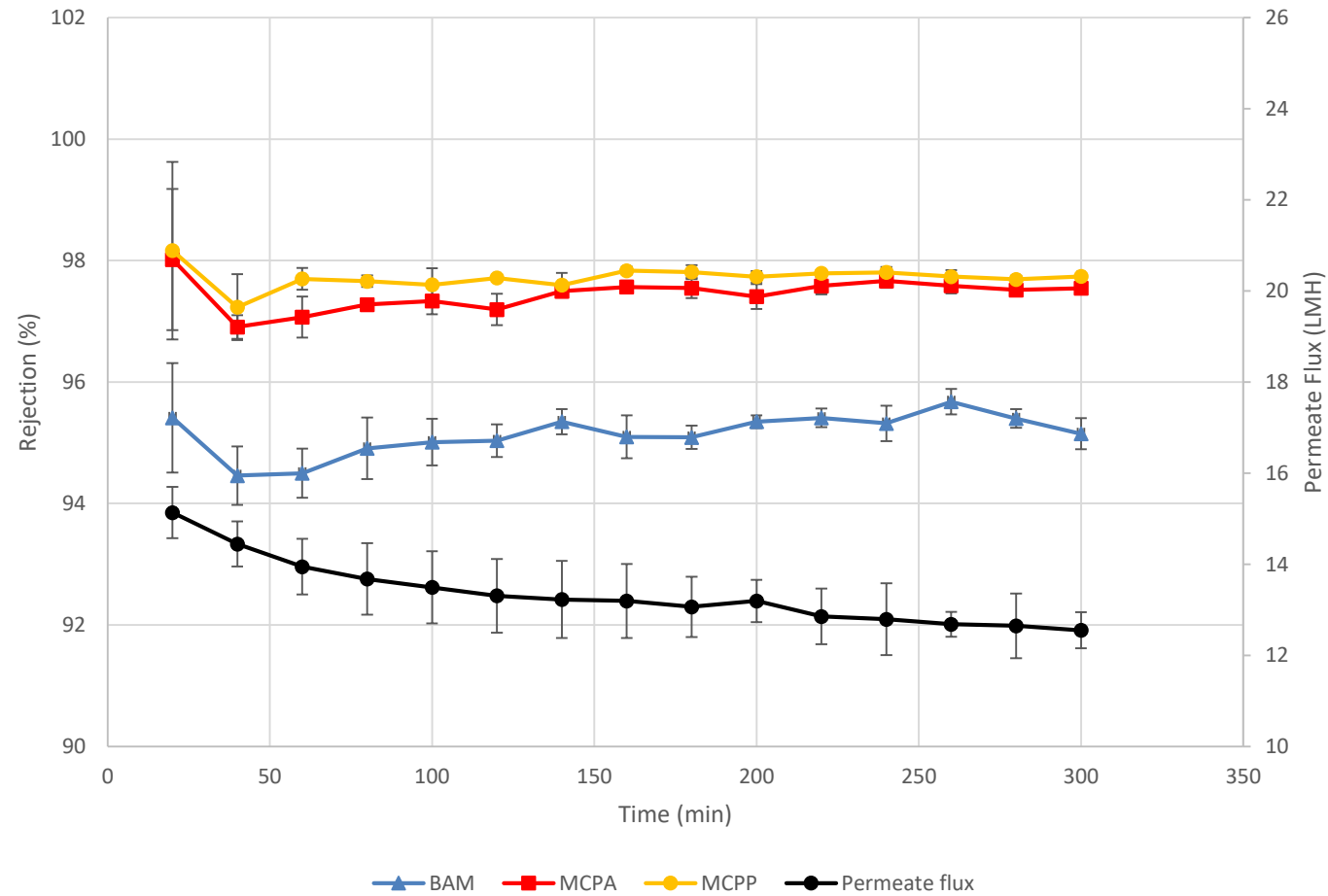
# Pesticides rejection in pure water

- Feed 2 L, 1 mg/L
- Draw 200 mL, 1 M NaCl
- Flat sheet membrane



# Pesticides rejection in Varde water

- Feed 2 L, 1 mg/L
- Draw 200 mL, 1 M NaCl
- Flat sheet membrane



# Pesticides rejection by different setups

	BAM (%)	MCPA (%)	MCPP (%)	Pure water permeate Flux (LMH)
Hollow fiber	98.1	98.6	98.9	15.8
Flat sheet	93.3	94.7	94.9	15.2
Small FO compartment	97.2	-	-	9.4

H. Madsen et. al., Journal of Membrane Science 476 (2015) 469–474



# Future work

- Use of the other water samples from Kolding and Hvidovre.
- Use of the other draw solutes: Glucose and Sodium acetate
- Study of effect of recovery on the membrane performance.
- Production of concentrates for biological treatment using different draw solutes
- Comparison of RO and FO in terms of scaling propensity
- Combination of FO and RO as an integrated membrane process.

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THANK YOU  
FOR  
ATTENTION!  
ANY QUESTIONS?